Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of:	)	
	)	
Digital Audio Broadcasting Systems	)	
And Their Impact on the Terrestrial	)	MM Docket No. 99-325
Radio Broadcast Service	)	

To: Marlene Dortch, Secretary, Via ECFS
Federal Communications Commission
Attn: Chief, Media Bureau

REPLY COMMENTS OF SUPERIOR COMMUNICATIONS, INC.

Superior Communications, Inc[1]. ("Superior"), pursuant to Section 1.415 of the rules, hereby files Reply Comments in connection with the Commission's Further Notice of Proposed Rulemaking and Notice of Inquiry (FCC04-99, released April 20, 2004) (FNPRM/NOI) in the above-referenced proceeding regarding implementation of In-Band On-Channel digital audio broadcasting (IBOC DAB) in the radio broadcast services. In support thereof, the following is shown:

A. FM Service Issues

Superior has reviewed comments by various parties in this proceeding and observes many concerns about interference. IBOC has proven in actual field tests to be harmful to first adjacent channel broadcasts. Many parties have also expressed concerns about rushing this proceeding using a proprietary digital compression scheme. The age-old adage "haste makes waste" is still valid and once should be kept in mind when making these monumental decisions that will affect future generations (maybe over the next 100+ years).

[1] Superior operates several non-commercial stations

Since FM was invented 70+ years ago it has been remarkably robust and been the most popular method of transmitting signals. Freedom from static, noise and excellent frequency response has the hallmark of FM broadcasts. IBOC threatens to reduce the service areas and robustness of this excellent medium. While IBOC is really IBAC (In-Band ADJACENT Channel) since the ODFM digital data is transmitted between 129 to 198 kHz, which is entirely on top the first adjacent frequency! Based on studies done by Barry McLarnon[2] the actual occupied bandwidth increases from 111 kHz to 222 kHz or a 100% increase. This is an alarming change of 16 db against a first adjacent station. This would be the equivalent of 100 kW FM station increasing its power over 3,000 kW. We have observed this degradation on local stations because of IBOC stations out of Detroit. Residents that once had near crystal clear reception of first adjacents now have nothing but a "sea of foaming" white noise. This ring of white noise interference is extending 25 - 30 miles or more from the "Class B" Detroit station. If all stations are forced to begin transmitting IBOC then coverage areas will be impeded even inside protected service areas. We are standing alone in the world with this IBOC implementation. Most other developed countries began Eureka 147 broadcasts a decade ago. In most cases there has only been limited interest even with the better Eureka 147 audio quality. With 800 Million standard receivers in use in the United States and only a handful of IBOC recievers is this really in the public interest? Is the general public clamoring for this new service? The answer is a resounding NO to both.

The FM IBOC compression algorithm is not near CD-Quality at only 96 kbps[3]. This is similar to the bit rate used for XM radio and obvious sibilance and high frequency harshness is ready observed on an A/B comparison. Our contention is 96 kpbs doesn't sound more natural than standard FM

[2] See attachment "A Look At the Digital Horizon" by Barry McLarnon of the Communications Research Center in Ottawa Canada.

[3] Actually cd-quality is 44,100 uncompressed stereo at 1376 kbps. Eureka 147 runs at 224 kpbs. See attachment Digital Radio Research (DRRI) inc. EIA/NRSC dab system lab test results: an assessment.

radio. It does have less noise in fringe areas, however then digital signal is much more prone to dropping out completely and reverting back to analog fm anyway, yielding no improvement. Why are we in a rush to impose a mandatory digital standard when we are only in the infancy of the digital audio age? Can the current IBOC system still be a viable system 70 years from now as the fm system has been? The while no one can predict the future, I'm pretty sure IBOC will flop in the same manner as HDTV. Basically the average consumer doesn't care.

Forced conversion to IBOC should never be required, in part, because the FCC is using a proprietary system. Conversion costs are estimated to around $75,000 per station. Our station group simply cannot afford to upgrade to IBOC because we rely on public support from donations. Any forced upgrade would come at the expense of local programming and staff.

If the free market place use of IBOC fails, then it fails. The government should not try to "restart" a failed IBOC effort because it obviously was not in the public interest.

The FCC's rush to implement IBOC may "miss" simpler, non-proprietary and better systems that have yet to be fully developed. Our engineering staff wishes to conduct experiments with an alternative non-proprietary digital system that does not increase interference. It is imperative that the Commission "leave the door open" for further innovation. We find it suspicious that the biggest proponents of the IBOC system are actually stockholders in Ibiquity. The Commission should not be bullied into accepting a flawed IBOC system.

B. <u>AM Service Issues</u>

We have noted comments that AM IBOC is “worth” the interference it causes. That sounds like a **“win–lose”** scenario to me. I totally disagree with the commenters that say that skywave service of AM stations is no longer useful. Class A AM stations, formerly referred to as I-A and I-B clear channel stations before a corporate name led to confusion of the term, render useful skywave service at night with news, weather, sports reporting and play by play sports into areas outside the NIF contours of local AM stations that might have such formats. The skywaves are used by many more persons than just hobbyists or "DXers". In addition, many Class B stations with high power, generally those with directional antennas and with more than 5000 watts of power at night, both those on designated clear channels (formerly Class II) and now regional channels (formerly Class III) provide useful de facto skywave service in many areas. These services are often not available on FM either because it is usually music oriented. The dismissal of skywave service by corporate interests as no longer useful does not represent fact and this should be ignored.

The attached article by Barry McLarnon also discusses that the effective bandwidth of an AM actually increases by 100% and violates the U.S. - Canadian Treaty. Ironically, the FCC forced AM stations in 1991 to convert to NRSC bandwidth of 10.2 kHz in order to reduce first-adjacent interference. All of that expensive NRSC improvement will be voided once IBOC spatter hits the air. This amounts to FCC “waffling” under pressure. If it was it was a problem “back then” then it still is a problem today. Nothing on the consumer end has changed.

If we review past decisions of the FCC in regard to trying to influence consumers and manufactures we found that it has completely failed. Motorola AM Stereo and NRSC AM have all been “scrapped” because consumers had no interest in the products.

C. Conclusion

We do not believe IBOC is ready for finalization yet. With 800 million standard receivers in use in the United States and only a handful of IBOC receivers we need to proceed with caution rather than rushing headlong into disaster. General public is not claiming for IBOC. The Commission should not be bullied into accepting a flawed and interference-prone IBOC system.

Respectfully Submitted,

___Ed Czelada___

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The Canadian View

A Look at the Digital Horizon

by Barry McLarnon

As we struggle to understand exactly what digital broadcasts are doing, it is helpful to know something about the broadcast bandwidth. Barry McLarnon has the credentials to comment on this; his involvement in developing a digital radio broadcast standard for Canada, based on the Eureka 147 system, dates back to the late 1980's. As Project Leader, Radio Broadcast Systems, at the Communications Research Center (CRC) in Ottawa, Canada, he was responsible for research on new digital radio broadcast systems.

[OTTAWA, Ontario, Canada - July 2004] In Canada, we are already veterans of digital radio broadcasting, having hitched our wagon to the Eureka 147 system more than a decade ago. There have been many potholes along that road, but that is a story for another day. We are also watching the fortunes of IBOC (In Band, On Channel) digital radio with great interest. If it becomes successful, perhaps there could be a fork in the road, and Canadian broadcasters might seek to use IBOC in addition to Eureka DAB.

In the shorter term, however, there is a more pressing concern: what does the future hold in terms of increased interference to Canadian AM and FM stations from across the border?

FM DIGITAL IBOC

The FM system is the simpler of the two hybrid IBOC systems, at least in terms of the transmitted signal. The digital power is contained in a single pair of symmetrical sidebands that surround the analog signal. The subcarriers making up each sideband are even distributed from about 129 kHz to 198 kHz away from the carrier frequency.

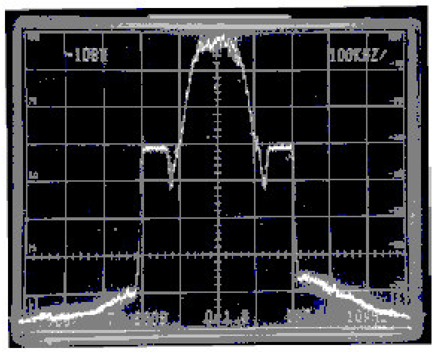
This means that 100% of the digital power falls in the first adjacent channels, so this system should be considered to be IBAC (In Band, Adjacent Channel) rather than IBOC. Since the total power of the digital signal is 20 dB down from the analog power (i.e., -20 dBc), it only increases the total power by 1% when it is added to form the hybrid signal. This may seem insignificant at first glance, but as the saying goes, the devil is in the details.

One measure of what happens to the signal when the IBOC sidebands are added is the change to the occupied bandwidth. This term is used somewhat loosely at times, but it has a precise definition as far as the ITU (International Telecommunications Union) and the FCC are concerned. It is the bandwidth that contains 99% of the total power (averaged over a suitable interval), with the remaining 1% split equally outside the upper and lower limits.

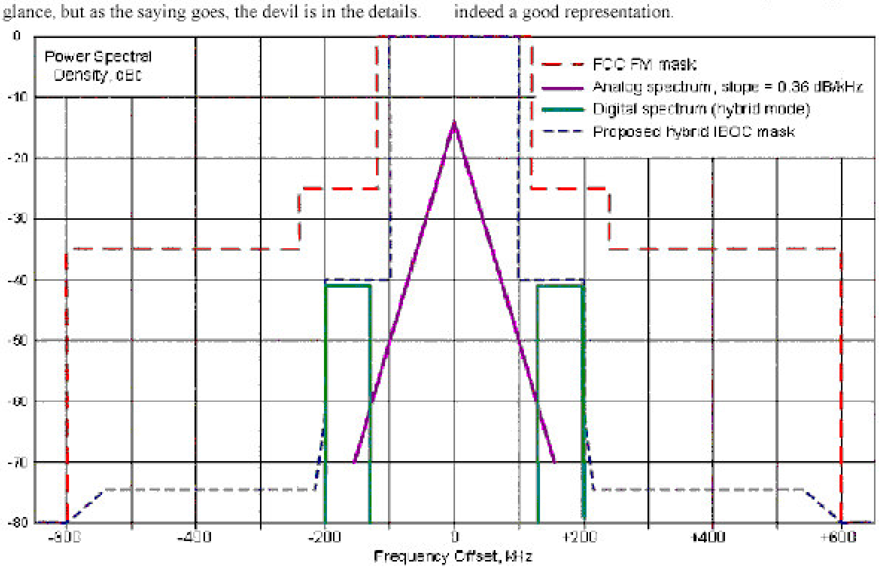
When symmetry about a center frequency prevails, as it should with most broadcast signals, we can dispense with the limits and simply talk about the occupied bandwidth as a single number. In order to calculate occupied bandwidth, we need a mathematical representation of the signal spectrum.

BASIC FM SIGNAL

Fortunately, there is a convenient model for the FM spectrum that is used in IBOC analysis. It dates back to the pre-iBiquity days, and continues to be used to this day. It was derived from observations of several FM stations in the Washington DC area, using a spectrum analyzer set for 1 kHz resolution bandwidth and five minute averaging.



In this model, the time-averaged signal has a triangular power spectral density when viewed on a logarithmic power scale, dropping off from a central peak at a rate of 0.36 dB/kHz. This was the average slope for the stations observed. I checked the power spectrum of all the local FM stations in my area, and found that the triangular shape was indeed a good representation.



Power Spectral Density for FM IBOC

A slope of 0.36 dB/kHz was also a reasonable approximation of the average, but there was a wide variation – I saw slopes ranging from 0.22 dB/kHz for heavily processed stations, to 0.70 dB/kHz for lightly modulated classical music and monophonic stations.

In any case, with a bit of calculus, it is easy to calculate the occupied bandwidth of such a signal, and it turns out to be very simple: if the slope is ß dB/kHz, then the occupied bandwidth is 40/ß kHz. This works out to be 111 kHz for the 0.36 dB/kHz slope that is said to be typical, and it ranges from 57 to 182 kHz for the stations I observed. In all cases, this is less than the nominal 200 kHz bandwidth of the FM channel.

ADDING IBOC

Now, let us recalculate the occupied bandwidth after a station goes IBOC. Because of those digital saddlebags now hanging on the FM signal, we have to take in considerably more of the analog signal before we reach the 99% total power point. For the "typical" FM signal with 0.36 dB/kHz slope, the new occupied bandwidth turns out to be 222 kHz. So, although it may seem counterintuitive, by increasing the total power by a mere 1%, we have increased the occupied bandwidth by 100%!

In fact, this doubling of the occupied bandwidth is independent of the slope, provided that the slope is 0.31 dB/kHz or higher. This certainly gives a hint that there will be increased interference to the adjacent channels, but we need to quantify this a bit further.

Again going back to the analog signal model and doing a bit more math, we can calculate the total power that is deposited into one of the first adjacent channels. It turns out to be very simple: -(100ß + 3) dBc (this is actually the total power in all of the adjacent channels on one side of the analog signal, but virtually all of it falls into the first adjacent). For the "typical" FM signal, this is -39 dBc, and is proportionately smaller or larger for the other cases.

When we add the digital signal (which, you will recall, is IBAC in disguise), we are dumping an additional -23 dBc into the first adjacent channel. This makes the total -22.8 dBc, or an increase of about 16 dB. Therefore, on average *adding IBOC to an FM station creates an increase of 16 dB in interference power that is co-channel to a first adjacent station.* For a lightly modulated signal with ß = 0.22 dB/kHz, the increase is a whopping 47 dB.

The spectral distribution of the interference is important, too. The analog interference power is highest at the edge of the first adjacent channel, and drops rapidly as its carrier frequency is approached. The digital spectrum, on the other hand, is flat, spanning the range from 2 to 71 kHz from the first adjacent carrier frequency. Therefore, it is likely to have an even greater impact than the 16 dB increase would indicate.

RECEIVER CONSIDERATIONS

This analysis helps to shed some light on the results previously published by iBiquity on "analog compatibility" of IBOC with several different FM receivers. For example, the Delphi car receiver continued to perform well when subjected to first adjacent analog interference at D/U (desired/undesired signal power) ratios as low as -14 dB. When IBOC was added to the interfering signal, however, reception became badly degraded at +6 dB D/U (the FCC protection ratio), and unusable at lower D/U ratios.

Similarly, in second adjacent interference tests, the Technics home receiver still functioned adequately at -40 dB D/U (the FCC protection ratio), but with IBOC added, it was unusable at D/U ratios below -30 dB. The latter situation is particularly interesting, since a second adjacent at -40 dB D/U creates a new first adjacent interference source at -17 dB D/U, which is 23 dB higher than the first adjacent protection ratio.

It should therefore come as no surprise that there are already reports coming in about stations losing fringe area coverage due to IBOC interference, and when IBOC becomes more widespread, coverage beyond the protected contours many stations now enjoy will largely be a thing of the past. Moreover, serious interference inside protected contours appears to be quite possible, which could prove to be interesting, even prompting some litigation.

AM IBOC

The AM IBOC system bears a superficial resemblance to the FM system, but it is different in several important respects. First, the transmitted spectrum is considerably more complex, consisting of three separate pairs of sidebands: the tertiary, secondary, and primary sidebands, located in the regions from 0 to 5 kHz, 5 to 10 kHz, and 10 to 15 kHz from the carrier frequency, respectively.

(Continued on Page 10)

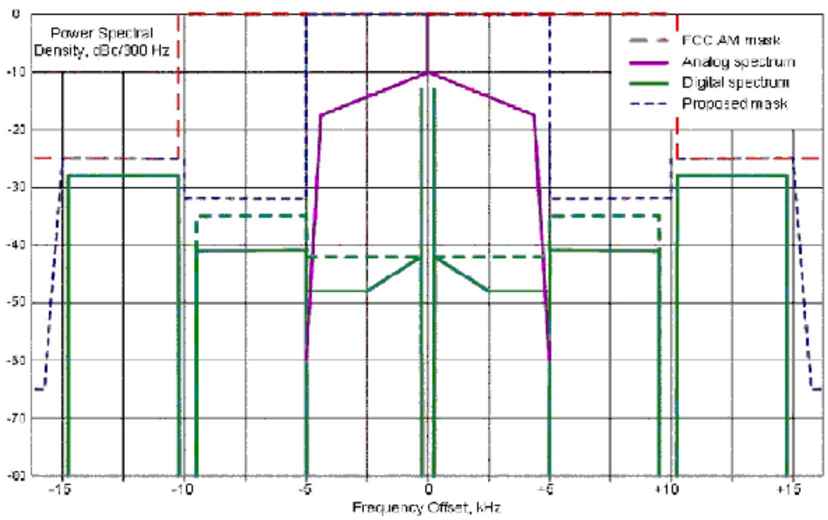
The Canadian View

A Look at the Digital Horizon

Continued From Page 8

The bandwidth of the analog signal is reduced so that it occupies only the ±5 kHz region. The tertiary sidebands that lie under the analog signal are modulated as quadrature pairs, producing a constant envelope signal which in principle should produce no audible output from a standard AM detector.

Because of varying power levels in the different sidebands, it is best to consider separately the three frequency zones in which those sidebands fall. In order to relate this to the real world, we will assume the analog carrier power is 50 kW; for lower transmitter powers, just scale the numbers appropriately. Here is how it breaks down:



Power Spectral Density for AM IBOC

Another difference from the FM system is the existence of two tiers of quality: core mode, which provides monophonic audio encoded at 20 kb/s, and enhanced mode, which raises the overall audio bit rate to 36 kb/s stereo and adds a 0.4 kb/s ancillary data stream. Core mode depends on the primary sidebands that, as we shall see, have much higher power levels than the other digital sidebands.

The upper and lower primary sidebands carry the same information, but are offset in time by about 4.5 seconds. This provides a time diversity function, so that impairments such as noise bursts do not interrupt the core data stream, provided they are short in duration.

For the enhanced mode to kick in, the data carried by the secondary and tertiary sidebands must be decoded with a sufficiently low error rate. Since they are at lower power levels and lack the time diversity feature, this mode is considerably less robust than the core mode, and its coverage contours tend to be significantly smaller.

Just how much smaller is difficult to discover, since iBiquity is careful not to disclose which digital mode is operative when they publish coverage maps for the hybrid AM system (except for some of the older tests – for an eye opener, go look up the one they did with KABL).

ANALYZING THE SPECTRUM

In any case, our focus here is interference to analog service. And to study that, we need to know what power is contained in the digital signal, and how its spectrum is distributed.

Most people probably assume the total digital power is 20 dB down from the analog as it is in the hybrid FM system – and IBOC proponents do not go out of their way to disabuse us of that notion. In fact, you never see the figure quoted anywhere. The only way to determine it is to get the system specification and do some calculations. We will do that, but here is a hint: the answer is nowhere near -20 dBc.

CALCULATING SPECTRAL POWER

0-5 kHz: In addition to the tertiary sidebands, there is a pair of reference subcarriers and a pair of data service subcarriers. The total power in the reference subcarriers is fixed (250 watts), but there are two choices of power levels for the rest. The total power in the 50 subcarriers making up the tertiary sidebands is 100 watts or 37.5 watts. The total power in the data service subcarriers is either 20 watts or 5 watts. So, the grand total for this zone is 370 watts or 293 watts.

5-10 kHz: This zone contains the secondary sidebands (50 subcarriers) plus a pair of data service subcarriers. Here again, there are two selectable power levels. The total power in the secondary sidebands is either 500 watts or 125 watts, and the power in the data subcarriers is 20 watts or 5 watts, so the total for this zone is 520 watts or 130 watts.

10-15 kHz: This is the simplest zone, yet the one that causes all of the trouble! It contains just the 50 subcarriers that make up the primary sidebands. The total power here is 2500 watts, or -13 dBc. This may come as a great surprise to some people! If you ask someone who is running AM IBOC, they will probably tell you that they set the power in this region to around -28 dBc.

The discrepancy occurs because most people measure AM IBOC using a spectrum analyzer with 300 Hz resolution bandwidth, which is the usual procedure for checking compliance with the NRSC mask. But that is the power spectral density, not the total power. To get the latter, you have to include the full span of the primary sidebands (about 8.7 kHz total) by adding 10log(8.7/0.3) or 15 dB.

So, let us sum it up: the total digital power from a 50 kW IBOC station will be either 293 + 130 + 2500 = 2923 watts, if the lower power setting is selected, or 370 + 520 + 2500 = 3390 watts on the higher power setting. This is only 12.3 dB or 11.7 dB below the analog power, respectively. The NRSC evaluation report on AM IBOC says that a total digital power of -12.4 dBc was used during testing, indicating use of the lower power setting, but the difference is really inconsequential. In round numbers, the total digital power is -12 dBc, or 8 dB more than in the FM system, and the majority of this power falls into the first adjacent channels.

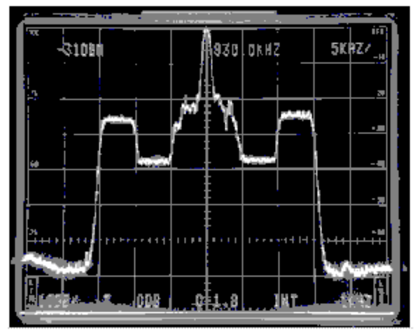
So, what does this do to the occupied bandwidth?

HOW WIDE IS IT?

Unfortunately, there is no convenient mathematical model for the analog signal, as in the FM case. Judging from spectrum plots I have seen, and what is required to stay under the NRSC mask, I will hazard a guess that the occupied bandwidth of a typical AM signal is no more than 14 kHz (i.e., 99% of the total power is within ±7 kHz of the carrier frequency).

Now, when the digital signal is added, it gets easier to estimate the occupied bandwidth. About 5% of the total power (analog plus digital) is in the primary sidebands, and they have a spectrum that is essentially flat, so we have to include about 4/5 of them on each side in order to get to 99% of the total power. This takes us out to nearly ±14 kHz, so the occupied bandwidth is about 28 kHz. So, by an estimate that is probably conservative, *adding IBOC to an AM signal increases its occupied bandwidth by roughly 100%.*

The total power output of the 50 kW station becomes 52,923 watts, a 5.8% increase. That is a lot more than in the FM system, but here again, the real problem lies in where that power goes within the spectrum. With that 2.5 kW in the primary sidebands, the station is in effect being allowed to establish two new 1250 W stations on the first adjacent channels. These "stations" are transmitting, essentially, wideband noise modulation at 100% duty cycle.



A Typical AM IBOC Spectrum

It is an amazing deal: each station gets two new ones, on channels for which they hold no license, with no technical studies or coordination required! However, anyone familiar with the AM band allocation standards should recognize this as a recipe for disaster.

LOST PROTECTION

Consider the protection for first adjacent stations. This was tightened up to +6 dB D/U by the FCC in 1991, but for the vast majority of stations, the old standard of 0 dB on protected contours still applies. It also applies to the international agreement between the US and Canada.

What this means is that if you have a first adjacent at 0 dB D/U, when they fire up IBOC, you also now have co-channel interference at +16 dB D/U. This is fully 10 dB higher than would be permitted if the usual +26 dB D/U co-channel protection rule were applied.

The Canada-US agreement also has second adjacent protection, set at -29.5 dB D/U. If a second adjacent station at this D/U level turns on IBOC, they will create a new first adjacent interference source at -13.5 dB D/U, which is 13.5 dB higher than would be permitted by the first adjacent protection rule.

Rising noise levels are always a concern in AM broadcasting, but in many ways IBOC is an unprecedented threat. If it achieves widespread use and operation is permitted at nighttime, the hybrid IBOC system will effectively cause a quantum leap in the AM band noise floor all over North America, and the coverage of AM stations will suffer correspondingly, especially in rural areas.

Broadcasters should be viewing this development with considerable alarm, and proceeding with caution instead of rushing headlong into disaster.

Barry McLarnon (VE3JF) holds a BS in Physics and MS in Electrical Engineering. He is a consulting engineer specializing in communications systems engineering. Mr. McLarnon has authored more than thirty technical papers and conference presentations related to radio communications engineering. bdm@bdmcomm.ca

Spectrographs Courtesy of Burt Weiner

DIGITAL RADIO RESEARCH (DRRI) INC.
EIA/NRSC DAB SYSTEM LAB TEST RESULTS: AN ASSESSMENT
Eureka 147 outperforms all in-band systems!

KEY FINDINGS

The Eureka 147 System produced results that were far superior to any of the IBOC systems with respect to audio quality, signal reliability and non-interference to existing analog services.

FM IBOC systems would produce unacceptable interference to their "host" FM station, as well as to nearby stations that operate on adjacent frequencies.

AM and FM IBOC systems would produce substantially-reduced service coverage, compared to that of their analog "host" stations.

The performance of FM IBOC systems degrades considerably, even to the point of failure, in the presence of multipath. The AM IBOC system cannot provide CD-Quality audio and produces impairments that expert listeners judge as "annoying".

BACKGROUND

On August 22, 1995, the Digital Audio Radio Subcommittee of the Electronic Industries Association (EIA) released the results of independent laboratory tests conducted on seven proponent Digital Audio Broadcasting (DAB) systems. (Two systems operated in t wo modes each, making for nine tests in total.)

Measurements and related audio recordings for each system were made at NASA’s Lewis Research Center (LeRC) in Cleveland OH. Subjective assessments of the audio recordings were carried out at the Communicat ions Re-search Center (CRC) in Ottawa ON, under contract to the EIA. These tests are the first time all proposed DAB systems were assessed by an independent body using the same evaluation criteria.

This report outlines conclusions drawn by Canadian DAB experts who have reviewed the results and were present at a technical tutorial session in Monterey, California, from 24-25 August 1995.

TESTS PERFORMED

The main purpose of the laboratory tests was to determine the basic digital audio quality produced by each system, its reception reliability, and its ability to co-exist with other stations, including the "host" analog station. In co-operation with the N ational Radio Standards Committee (NRSC), the EIA developed a complex series of tests to determine these factors. Each proponent had the opportunity to propose system-specific tests that would best illustrate its operating features. All system proponent s took an active part in the subcommittee that developed the testing procedures. Each system was operated in accordance with the developer’s specifications and tests were conducted using DAB encoders and receivers that were supplied by the proponents them selves. SYSTEMS TESTED

The DAB systems (and modes) listed in the Appendix were evaluated in the EIA tests. All comments and observations in this report relate only to the first seven system proponents listed.

i.e. Eureka 147 and the six In-Band On-Channel (IBOC) proponents. T he AT&T In-Band Adjacent-Channel (IBAC) system is not a serious contender for a North American standard, as it utilizes adjacent FM channels and evidently would require significant frequency re-shuffling in most markets to make it practical. The VOA/JPL system is not discussed, since it is designed for satellite-delivered DAB in the 2.3 GHz band, allocated only in the USA and India.

TEST RESULTS

When the basic digital audio quality of each proponent is assessed in a lab setting, using strong signals and no induced impairments, the ratings for all system proponents, with the exception of the USA Digital AM IBOC system, are quite similar.

The Eureka 147 system (224 kbits/sec) rated the highest of all, even though the two USA Digital FM systems employ a higher data rate (256 kbits/sec) and use the same MUSICAM audio coding system.

Even with strong signals and no interference, the USA Digital AM IBOC system suffers audio quality impairments that experts judge to be "annoying"; consequently, this system is not capable of providing "CD-Quality" DAB service.

Although all DAB receivers require time to recover when signals fail or listeners change frequencies, the recovery time of IBOC receivers is far too long to be practical in a real-world environment. The Eureka 147 system generally recovers from signal loss in 1 second or less.

The IBOC systems can take from 5-9 seconds to recover.

When tested with five common household, portable, and auto receivers with known operating characteristics, IBOC FM DAB produces significant impairments to existing analog services on first and second-adjacent channels.

In a majority of the tests, expert listeners judged the stereo FM analog service to be "worse" or "much worse" when an adjacent-channel station, carrying an IBOC DAB service, is present. This interference tends to worsen when multipath occurs. FM stations operating one channel apart on the dial are said to be "first-adjacent", while those that are separated by two channels are "second-adjacent".

Multipath interference occurs when FM signals reflect from large objects, such as buildings and mountains, causing several time-delayed versions of the same signal to arrive at the receiver. When tested with five common household, portable, and auto receivers with known operating characteristics, IBOC FM DAB produces a significant impairment to the quality of the FM stereo audio on its "host" analog station.

IBOC signals produce objectionable background noise in FM analog re-ceivers. Many of the test reports from expert listeners said that the quality of the FM stereo analog service was "worse" or "much worse" when the station was carrying an IBOC DAB sign al. IBOC impairments to the FM stereo service are more substantial on home tuners than on auto receivers, probably due to the reduced bandwidth of the latter.

If two FM stations having a first or second-adjacent channel relationship (and standard geographical spacing) were both to imple-ment IBOC, their useful DAB service areas would be significantly less than their analog coverages (up to 32% for first-ad jacent Class C1 stations), in the zone between the two stations.

FM IBOC system performance and interference impairment worsens significantly in the presence of multipath.

Of the IBOC systems, the AT&T/Amati system performed best in a multipath environment, although failures still occurred under certain conditions. The USA Digital FM-1 and FM-2 systems generally produced degraded performance (or failed completely) whenever multipath was added to the signal.

If two neighbouring first-adjacent-channel AM stations were both to implement IBOC DAB, the digital signals would fail wherever the desired station's signal is not at least 34 times stronger than that of the undesired station.

Many AM stations in urban markets would experience DAB coverage that is substantially smaller than their AM service areas. Nighttime AM DAB service would likely be impractical for most stations, due to the presence of strong adjacent-channel skywave signals.

CONCLUSIONS

The independent test results provided by the EIA confirm that the digital radio concept that Canada has developed (Eureka 147 in a new band at 1452-1492 MHz) will indeed provide the highest quality DAB service. The tests showed the Eureka system to be fa r superior technically to any other proponent system and confirm the extensive evaluations conducted in Canada and Europe since 1990. Moreover, as Eureka 147 will operate in a new band, it automatically avoids any impairments caused to, or suffered from, existing analog services. The In-Band systems showed particularly badly with respect to the key attribute their proponents have always touted - their ability to co-exist in the AM/FM bands without causing interference to analog services. Demonstrations in carefully controlled env ironments may have produced promising results previously. But the independent lab tests show that IBOC fails when it is operated using simulations of real-world impairments, such as multipath and adjacent-channel interference.

The next step in the evaluation process is to examine system performance in the field. Current plans of the joint EIA/ NRSC testing committee call for this to be done in the San Francisco area later this Fall.

APPENDIXSystem NameSource CodingData RateSystem TypeProposed Band Used Tested(kbits/sec)

Eureka 147 MUSICAM 224 New-Band 1452-1492 MHz
Eureka 147 MUSICAM 192 New-Band 1452-1492 MHz
USA Digital FM-1 MUSICAM 256 In-Band, On-Channel (IBOC) 88-108 MHz
USA Digital FM-2 MUSICAM 256 In-Band, On- Channel(IBOC) 88-108 MHz
USA Digital AM MUSICAM92 In-Band, On-Channel (IBOC) 525-1705 kHz
AT&T/Amati LSB PAC 128 In-Band, On-Channel (IBOC) 88-108 MHz

AT&T/Amati DSB PAC 160 In-Band, On-Channel (IBOC) 88-108 MHz
AT&T PAC 160 In-Band, Adjacent Channel (IBAC) 88-108 MHz
VOA/JPL PAC 160 Direct Broadcast Satellite 2310-2360 MHz